1958

The Physiography of Canada

Lockheart R. Gray

THE PHYSIOGRAPHY OF CANADA

A thesis

Presented to

The Faculty of the Department of Geology

University of North Dakota

In Partial Fulfillment

of the Requirements for the Degree

Bachelor of Science of Geology

---

by

Lockhart R. Gray

May, 1958

ABSTRACT

The physiographic features of Canada have a complex history which involve a Precambrian peneplain, followed by a long period of sedimentation interrupted in places by diastrophic events, and finally extensive glaciation. Since the turn of the nineteenth century several men have proposed classifications of these features, and have divided Canada into a number of physiographic provinces. A review of these classifications shows that Canada may be divided into six major divisions, each characterized by a continuity of physical aspects.

CONTENTS

	manuscript page
Abstract	i
Introduction	1
History of the physiographic features	1
Laurentian peneplain	2
Periods of sedimentation	3
Diastrophic events	5
Pleistocene glaciation	6
Classification of the physiographic features	8
Thayler's classification	8
Other classifications	9
Stockwell's classification	12
Major physiographic divisions of Canada	14
The Appalachian Region	14
The Hudson Bay and St Lawrence Lowlands	17
The Canadian Shield	19
The Interior Plains	20
The Cordilleran Region	21
The Arctic Archipelago	23
Conclusion	23
References cited	25

ILLUSTRATIONS

		manuscript page
Plate 1	Physiographic divisions of Thayler (1918)	10
2	Physiographic divisions of Stockwell (1957)	13
3	Physiographic divisions of the Appalachian Region	16
4	Hudson Bay and St Lawrence Lowlands	18
5	Physiographic divisions of the Cordilleran Region	22

INTRODUCTION

The purpose of this report is to discuss the physiographic divisions of Canada with regard to the geologic history of the physiographic features and to the different classifications which have been proposed.

Canada occupies approximately the northern half of the continent of North America, except for Alaska, and contains within its borders some 3,577,163 square miles of land (Stockwell, 1957, p.1).

The history of the physiographic features is reviewed as an aid to the understanding and evaluation of the different classifications that exist. The previous works on the physiography of Canada considered in this report include those of W. N. Thayler (1918), W. W. Atwood (1940), A. K. Lobeck (1950), and C. H. Stockwell (1957). The major physiographic divisions recognized in this report are those described by C. H. Stockwell in his 1957 publication.

I would like to acknowledge the guidance received from Mr. F. D. Holland, Jr. in the preparation of this thesis.

HISTORY OF THE PHYSIOGRAPHIC FEATURES

Recorded in the physiographic features of Canada are

a number of historical events which date back to Precambrian time. The events of this early period have been reconstructed from a study of the complex crystalline rocks of Precambrian age which crop out in the Canadian Shield. During this period sedimentation, volcanism, and orogenic movements took place forming complex metamorphic rocks of with considerable topographic relief. (Dunbar, 1957, p. 101-105). Near the close of this period the rocks of the Canadian Shield were subjected to subaerial erosion for a considerable length of time which resulted in the surface of low relief now exhibited by these rocks.

Laurentian Peneplain

The remarkable even skyline exhibited by the Precambrian rocks exposed over a large area in eastern Canada has led many people to believe that these rocks were subjected to peneplaination prior to Paleozoic time. The development of this peneplain is believed by Stockwell (1957, p. 45) to have taken place near the end of Precambrian time and possibly extended into the early part of the Paleozoic. This peneplain is referred to as the Laurentian Peneplain by Wilson (1903, p. 653) who presents his views on this area in the following statement: "From a physiographic standpoint the Canadian shield may be described as an ancient peneplain which has undergone differential elevation; has been denuded; and subsequently

slightly incised around the uplifted margin."

Periods of Sedimentation

Following this period of plaination certain parts of the continent were downwarped allowing the Paleozoic seas to encroach upon the land and deposit sediments.

Subsidance on the flanks of the Canadian shield during the early part of the Paleozoic Era resulted in the formation of an extensive coastal plain, remnants of which are preserved in the lowlands of Hudson Bay and St. Lawrence. Deposition of sediments during Ordovician, Silurian, and Devonian times resulted in the development of distinctive belts on this coastal plain. Erosion on the surface of these gently dipping strata has produced a number of cuestas facing the shield. Wilson (1903, p. 617) describes this area in the following manner:

> "In its general features eastern North America presents in a most striking manner and on a large scale what may be regarded as a typical development of physiographic forms characteristic of a belted ancient coastal plain centered around an oldland area."

One of the features of this ancient belted coastal plain that is preserved in the present landscape is the famous Niagara Cuesta which stretches from the west end of Lake Ontario across the Ontario peninsula and passes through Manitoulin Island. Other places where similar features of this coastal plain are preserved are on Anticosti Island, and along the western margin of Lake

Lake Winnipeg, Lake Athabasca, Great Bear Lake, and Great Slave Lake, where cuestas formed on these coastal plain sediments help form the basins of these lakes (Tayler, 1950, p. 41).

While this coastal plain was forming around the shield other areas were also submerged and receiving sediments. In the maritime provinces of New Brunswick, Nova Scotia, and Newfoundland sediments were being deposited in the Appalachian Geosyncline as well as in isolated basins, which today contain the important coal deposits of this region (Tayler, 1950, p. 43-45). In Western Canada sedimentation was taking place in the great Cordilleran Trough that existed during Paleozoic time. Also receiving sediments during this time were many of the islands in the Arctic region. The record of sediments in this area is verified by Kurtz, McNair, and Wales (1950, p. 1479) who state that "Cambrian and Ordovician sediments at least 3450 feet thick overlie Precambrian gneisses along the southern shore of Devon Island."

Sedimentation during Mesozoic time was restricted in a large part to the Rocky Mountain Geosyncline, which received vast deposits of sediments during the Triassic, Jurassic, and Cretaceous periods (Tayler, 1950, p.45). The sediments of chief importance that were laid down following the Cretaceous period were deposits of glacial material. These deposits in the form of moraines, kames,

drumlins, and eskers make up some of the dominant features of the landscape in many parts of Canada.

Diastrophic Events

Several diastrophic events are reflected in the present topography of Canada. Some of the early diastrophic events are recorded in the highly contorted and metamorphosed rocks which form the highlands in the maritime provinces of Eastern Canada. This area was affected by three mountain building periods during Paleozoic time; the Taconic at the end of the Ordovician period, the Acadian folding in Devonian time, and the Appalachian folding and faulting during Permian time (Putnam, 1952, p. 43).

Another area in Canada where diastrophic events have produced dominant relief features is located along the Pacific Coast. Eardley (1951, p. 13) states that in late Jurassic and early Cretaceous time intense folding and batholithic intrusions resulted in the formation of a large part of the Coast Range of British Columbia. This was followed closely by another, the Laramide Revolution which marked the close of the Mesozoic Era. This orogenic disturbance is described by Dunbar (1957, p. 364) in the following statement: "At this time the floor of the great geosyncline, so recently covered by the Cretaceous sea became the scene of foldinf and thrusting on a collosal scale,resulting in the Rocky Mountain System." This

mountain range forms a very formidable feature in the physiography of Canada with peaks in the neighborhood of 10,000 feet (Stockwell, 1957, p. 291).

Pleistocene Glaciation

Probably the most widespread influence on the physiography of Canada was the work done by the ice sheets which spread over the country during Pleistocene time. The work done by these large sheets of ice includes gouging and scouring of the land surface, blocking of existing drainage channels, depression of the land surface due to the weight of the ice, and deposition of material carried by the ice. The ice sheets that existed during this time were of two types; continental glaciers which were large extensive bodies of ice that moved slowly over the interior of the country, and alpine glaciers which were less extensive ice sheets that accumulated in the mountainous regions of Labrador and British Columbia.

The work done by the alpine glaciers is expressed by sharp peaks, U-shaped valleys, Cirques, and fjords. Putnam (1952), relates in his discussion of the Torngat Mountains of eastern Labrador that many ice scoured valleys now invaded by the sea form fjords similar to those of Norway. In the mountains along the west coast of Canada strong evidence of alpine glaciation is indicated by thick deposits of drift found in many of the valleys which is in

some places as much as 600 feet thick (Stockwell, 1957, p. 461).

The continental glaciers which spread over the central part of the country had a pronounced effect on the drainage of this area. The movement of the ice southward in Manitoba blocked the northward flowing rivers in this area causing the water to pond at the foot of the glacier. This led to the formation of an extensive lake in this area known as Lake Agassiz.

This lake, which is believed to have existed for about 1000 years, covered an area at the time of its maximum development some 700 miles long and 250 miles wide centered around the present Lake Winnipeg (Atwood, 1940, p. 213). As the ice receeded the drainage to the north was restored and the level of the lake dropped in stages to the present level of Lake Winnipeg. During each stage beaches and deltas were formed at the margin of the lake which are preserved in the present-day landscape.

Probably the most pronounced effects of the continental ice sheets are preserved in the Great Lakes region. The glacial history of this area is very complex; the major effect of the glacier being the formation of the lake basins due possibly to the gouging of soft rock formations and a depression of the surface in this area. Stockwell, (1957, p. 463), states that depression of the surface in the region of the Great Lakes was in the neighborhood of

500 to 800 feet.

Apart from these major features caused by the continental ice sheets, it may be said that the land surface throughout the interior part of Canada is characterized by glacial features developed during Pleistocene time. Over the area of the Canadian shield the effects of glaciation are seen in the drift-filled stream channels and the numerous lakes occupying basins formed by gouging or blocked by drift. Depositional features in the form of eskers, drumlins, and moraines are common features of the topography in the southern parts of many of the provinces.

CLASSIFICATION OF THE PHYSIOGRAPHIC FEATURES

The distribution of sediments and the location of the different orogenic movements in the development of the physiographic features of Canada have served to outline a number of physiographic provinces. As pointed out by Lobeck (1950), these provinces occur as linear belts, parallel to the coast lines, which are in most cases continuous throughout the length of the continent. It was this continuity of physiographic provinces that led to one of the early classifications of the physiography of Canada.

Thayler's Classification

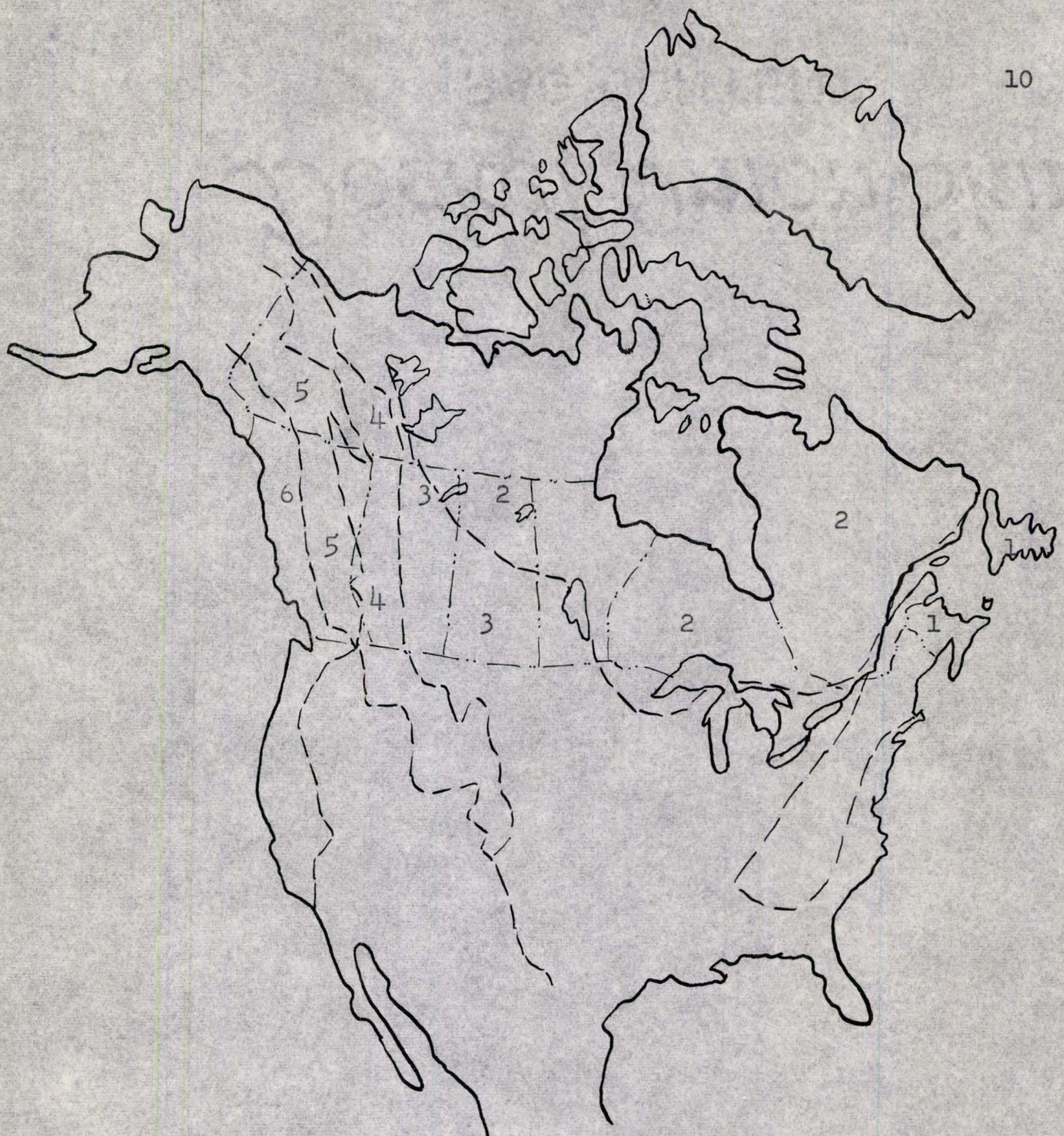
A pioneer of Canadian physiography, W. N. Thayler, published a paper in 1918, entitled " The Northward

Extentions of the Physiographic Divisions of the United States", in which he pointed out that many of the physiographic divisions recognized in the United States could be extended into Canada. The major divisions recognized in Canada by Thayler are shown on plate 1. Except for the Arctic region of northern Canada which was not considered in this classification, the major divisions recognized at this time differ only slightly from the 1957 classification of Stockwell.

Other Classifications

Two other classifications that have been published are those of W. W. Atwood (1940), and A. K. Lobeck (1948). Both of these men have considered the physiographic divisions of Canada on a continental basis.

The classification proposed by Atwood indicates only the major physiographic divisions, and is very similar to that of Thayler, except for the mid-continent region. Here Atwood recognizes two major divisions; the Central Plains Province which borders the Canadian shield from Quebec City, Quebec, to central Saskatchewan, and the Great Plains Province which forms a belt extending east from the foot of the Rocky Mountains to the Canadian shield in the north and bordering the Central Plains Province in southern Saskatchewan along a boundary marked by the Missouri Coteau. Although this classification may be



Major Divisions in Canada

1. Appalachian Highlands
2. Laurentian Plateau
3. Interior Plains
4. Rocky Mountain System
5. Intermontane Plateaus
6. Pacific Mountain System

scale in miles

0 300 600

Plate 1 Physiographic Divisions of Thayler (1918).

useful, it seems more logical to consider the mid-continent region of Canada as one major division having two subdivisions.

A more detailed classification is that proposed by Lobeck (1948), in which he recognizes large physiographic units referred to as major divisions, which are divided into provinces, and sections which are subdivisions of provinces. Although this classification is more detailed than the others, it appears to have some objectionable features.

One objectionable feature is that he includes the Hudson Bay Lowlands as a section of the Laurentian Upland Province. It does not seem reasonable that a lowland such as this developed on sedimentary strata should be included in a province characterized by crystalline rocks. Another objection to this classification is the inclusion of the Arctic Archipelago, a group of islands most of which are covered by sedimentary strata, as a subdivision of the Canadian Shield. It is the opinion of the writer that the name Canadian Shield should pretain to that part of the continent characterized by the exposure of complex Precambrian rocks, and that the Arctic Archipelago should be a separate major division pretaining to the islands north of the continental land mass.

Lobeck has recognized in each province a number of small divisions called sections which he states are

recognized primarily on the basis of geographic location. Such a basis for physiographic division seems undesireable particularly in the Canadian Shield, a continuous landmass characterized by a surface of low relief developed everywhere on crystalline rocks. Other criteria that might be considred in dividing the Canadian Shield are rock types, vegetal distribution, and drainage basins.

Stockwell's Classification

The classification of Stockwell (1957), divides Canada into six major physiographic regions which are outlined on plate 2. The main difference between the classification of Stockwell and that of Thayler is that Stockwell considered more closely the geographic distribution of the physiographic features. This is indicated by the division of the Interior Plains as recognized by Thayler, into two provinces; the St. Lawrence Lowlands east of the Great Lakes, and the Interior Plains west of Lake Winnipeg. Stockwell also recognizes the Arctic Archipelago as a major division of Canada. Unlike any of the preceeding classifications, Stockwell combines the Hudson Bay lowland with the St Lawrence lowland to form one major division. He justifies the combination of these two geographically separated lowlands by pointing out that both lowlands are developed on sedimentary rocks of the same age which were deposited as part of the ancient coastal plain that

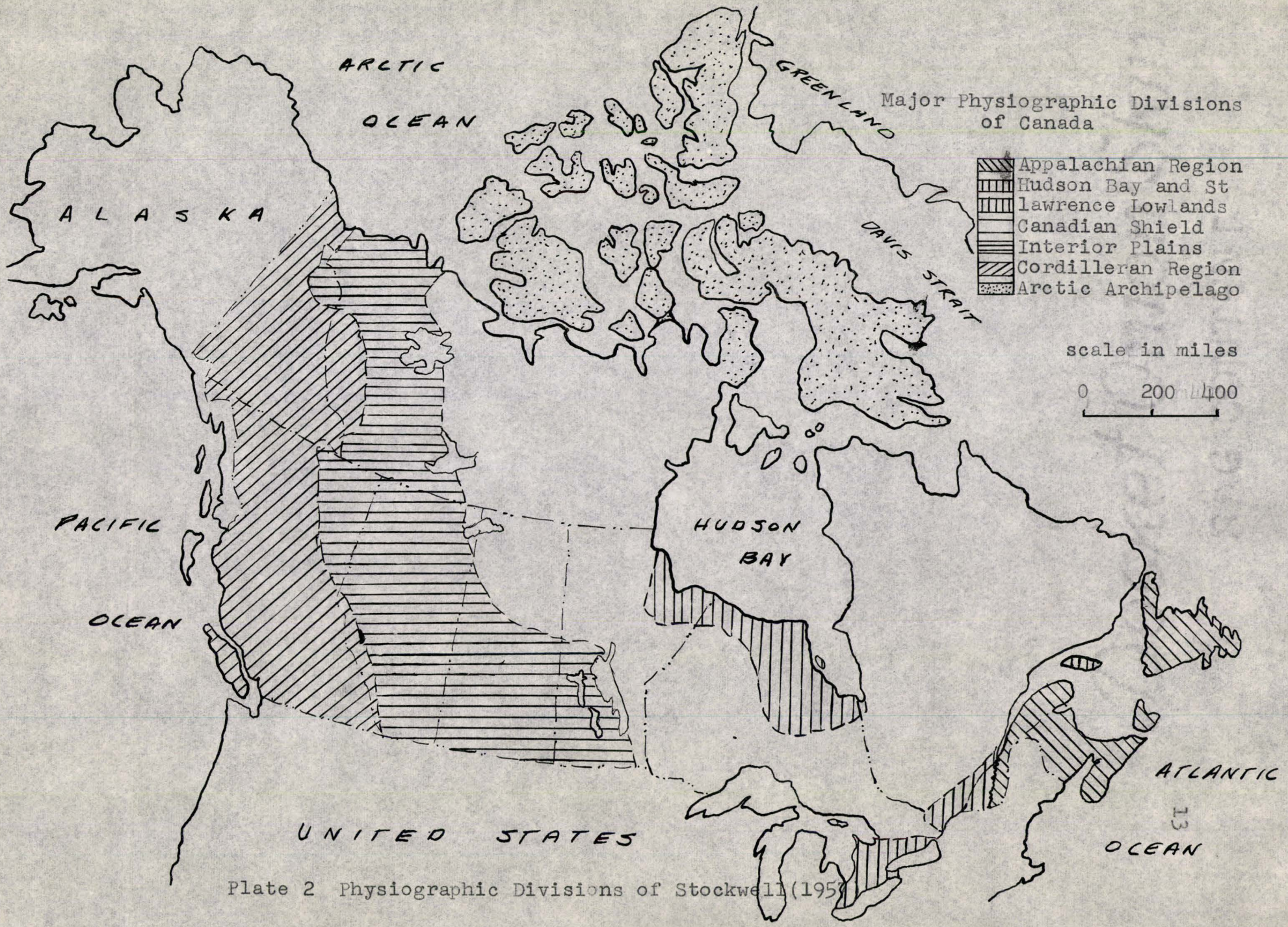


Plate 2 Physiographic Divisions of Stockwell (1957)

bordered the shield during early Paleozoic time. Stockwell also differs from the others in his classification of the mountainous region in western Canada. Here Stockwell recognizes one major division, the Cordilleran Region, which includes three major divisions recognized by the others. This grouping seems justified particularly in Canada where the two mountain systems; the Rocky Mountain System and the Pacific Mountain System, along with the Intermontane Plateaus merge together to form an almost solid mountainous along the Pacific Coast.

MAJOR PHYSIOGRAPHIC DIVISIONS OF CANADA

The physiographic features of Canada seem to divide most readily into six major divisions. For a discussion of the aspects of these divisions, the six major divisions of Stockwell (1957), will be considered. Since a complete description of each division cannot be treated adequately in this paper, only the boundaries and dominant physical aspects will be discussed.

The Appalachian Region

This major division consists of a belt of land along the east coast of Canada which includes the provinces of New Brunswick, Prince Edward Island, Nova Scotia, the island of Newfoundland, and a portion of Quebec east of the Logan Fault. Except for the Logan Fault, which forms

the boundary of this division from the north end of Lake Champlain to Quebec City, this region is completely surrounded by water.

As shown on plate 3, this region may be divided physiographically into uplands and lowlands. The lowland area being somewhat below 500 feet, while the uplands range from 500 to 2000 feet in altitude. The mountains of this region trend generally in a northeast direction and are made up of strongly folded metamorphic rocks which are the result of the orogenic movements in this region during Paleozoic time. Volcanic activity in this area has produced "trap" ridges which also comprise uplands. One notable is North Mountain in Nova Scotia which lies parallel and adjacent to the Bay of Fundy (Lobeck, 1950, p. 4).

The lowlands of this region are developed on the less resistant rocks such as sandstone, shale, limestone, and gypsum which are dominantly younger than Devonian in age (Eardley, 1951, p. 172). These lowlands generally appear along the coast, slope gently seaward, and display a diversity of elevation and form.

Another feature of this region is the rugged coastline particularly displayed in Nova Scotia along the east coast and in the Bay of Fundy. Putnam (1952, p. 77), attributes this feature to submergence caused by either downwarp or faulting as is the case in the Bay of Fundy.

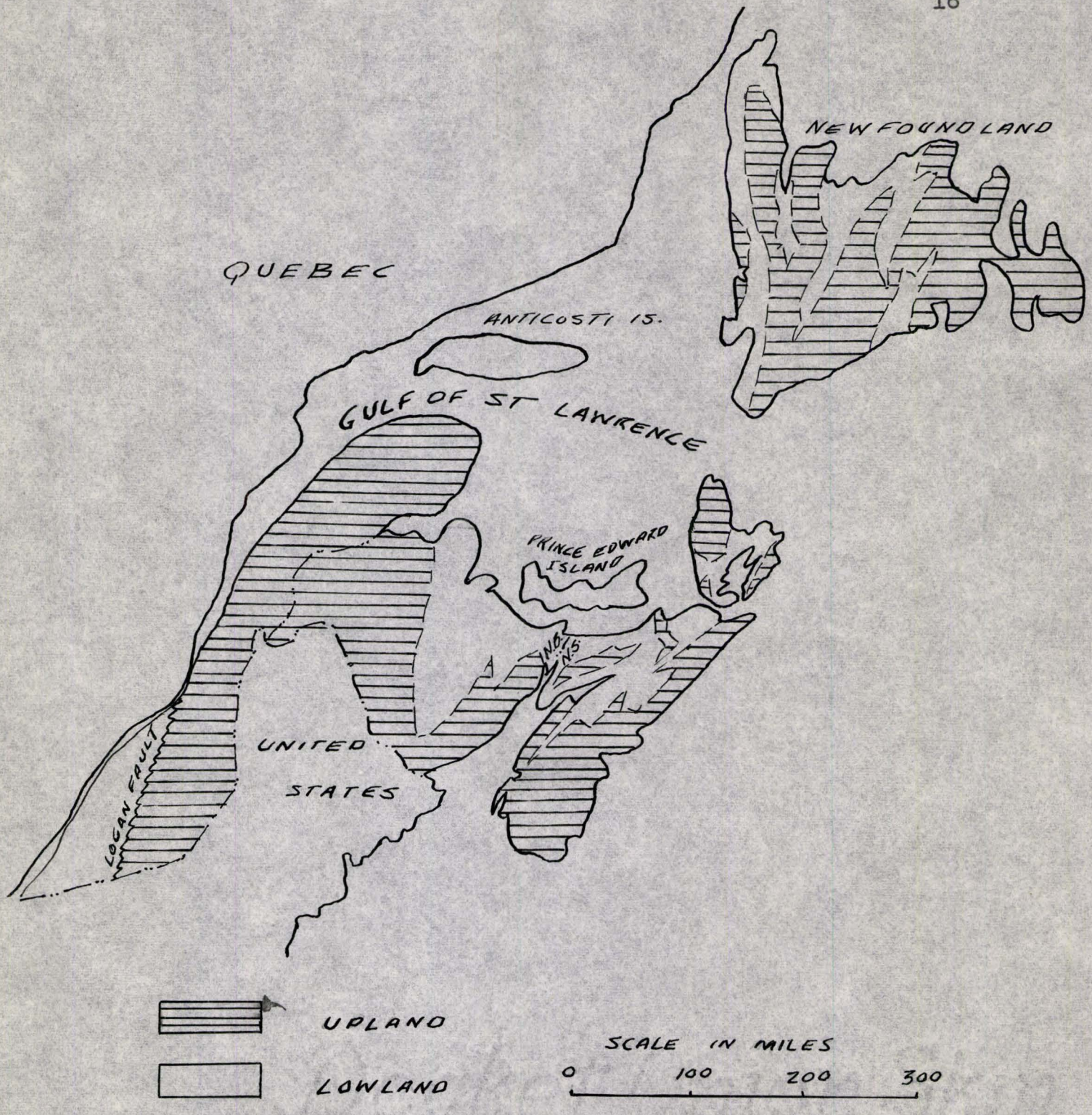


Plate 3 Physiographic divisions of the Appalachian Region (after Eardley, 1951).

Glaciation has also played a part in forming the physiography of this region as moraines, drumlins, kames, and eskers are common features of the topography.

The Hudson Bay and St Lawrence Lowlands

This major division is composed of two geographically separated lowlands which are both remnants of a former coastal plain. The Hudson Bay Lowlands form a linear belt stretching from the Churchill River in Manitoba, along the south shore of Hudson Bay and James Bay to the Ontario-Quebec boundary. The St Lawrence Lowlands which are separated from the above mentioned by an area of Canadian Shield are located along the North Shore of Lake Erie and Lake Ontario and extend up the St Lawrence River to Quebec City. This division also includes islands in the north of Lake Huron and in the Gulf of St Lawrence. The geographic distribution of the lowlands which comprise this major division are shown on plate 4.

As the name implies, this division is characterized by lowlands developed on gently dipping, unfolded Paleozoic rocks. Cuestas are a common feature of this division with the Niagara cuesta of the St Lawrence Lowland being the most pronounced. This cuesta is held up by resistant Silurian rocks and rises to 650 feet near the west end of Lake Ontario dropping off along the shore of Lake Huron to 250 to 300 feet (Stockwell, 1957, p. 207).

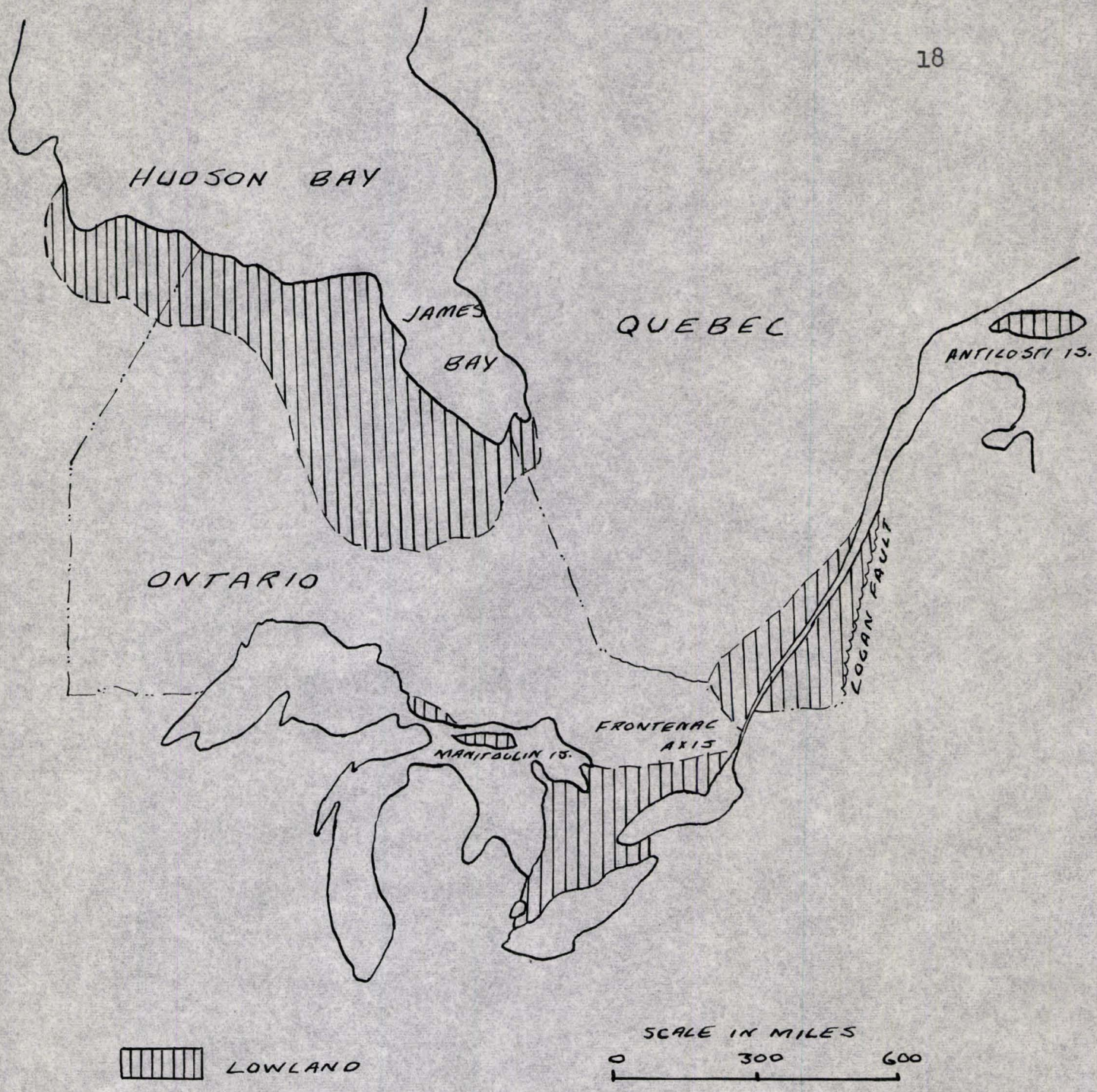


Plate 4 Hudson Bay and St Lawrence Lowlands (after Stockwell, 1957).

The Hudson Bay lowland is a low swampy plain developed on similar rocks to those in the St Lawrence lowlands. The only prominent topographic feature of this area is a low escarpment at the south boundary of this coastal plain (Stockwell, 1957, p. 211).

The Canadian Shield

The Canadian Shield is the largest major division in Canada and comprises over half the land mass. This broad region forms a belt of land surrounding Hudson Bay and James Bay in a U-shaped manner covering a large part of Quebec, Ontario, Northern Manitoba, and the Northwest Territories. The boundary of this division is marked everywhere by the edge of the Precambrian rocks which are characteristic of the shield.

The shield is characterized by exposures of crystalline Precambrian rocks which form a surface of marked low relief. The only notable exception to this low relief is the Torngat Mountains, which stretch northward along the east coast of Labrador. Apart from these relief features, the dominant physical aspect of this area are glacial features.

The work of the great ice sheets is responsible for the drainage and surface deposits found on the shield. The drainage of this region consists of a number of shallow lakes and swamps connected by poorly developed streams.

These poorly drained lakes separated by exposures of crystalline rocks partly covered by glacial drift are a characteristic feature of this large region.

The Interior Plains

Stretching westward from the boundary of the shield to the foot of the Rocky Mountains is a broad expanse of rolling countryside known as the Interior Plains. This major division extends from the international boundary to the Arctic Ocean and includes parts of Manitoba, Saskatchewan, Alberta, British Columbia, and the Northwest Territories.

This great plain is developed on relatively unfolded sedimentary rocks which have been deeply incised by the major streams of this area. The topography of the interstream areas of this region range from gently rolling surfaces to belts within which irregular hills and hollows present an uneven surface(Stockwell, 1957, p. 248).

The prominant physiographic feature of this area is the Manitoba Escarpment facing eastward onto the Manitoba lowland above which it rises 500 to 1900 feet. This escarpment held up by Mesozoic rocks which dip gently to the southwest, is known at different places from south to north as Pembina, Riding, Duck, and Porcupine Mountains(Stockwell, 1957, p. 249).

The Cordilleran Region

This major division comprises a mountainous belt some 500 miles wide which stretches along the west coast of Canada from the international boundary to Alaska. The inland boundary of this division is formed by the Rocky Mountain front which borders the Interior Plains.

As shown by plate 5, this area is dominantly a mountainous region containing small areas of plateaus, plains, and lowlands. Three subdivisions called systems are recognized by Stockwell in this major division: the eastern system containing the folded Rocky Mountains, the interior system characterized by diversified topography developed on volcanic rocks primarily along with some metamorphic and sedimentary rocks, the western system composed predominantly of mountains resulting from great batholithic intrusions. The lowlands of this region form only a minor part of the landscape being developed along the major streams of the area, as in the case of the Frazer River Valley. Much of the surface in this major division lies above 2000 feet and the majority attains an altitude above 4000 feet

Glacial features are also characteristic of this region which has much of the surface of lower altitudes covered with sheets of drift. The surfaces at higher altitudes are marked by cirques, U-shaped valleys, and hanging valleys (Putnam, 1952, p. 426).

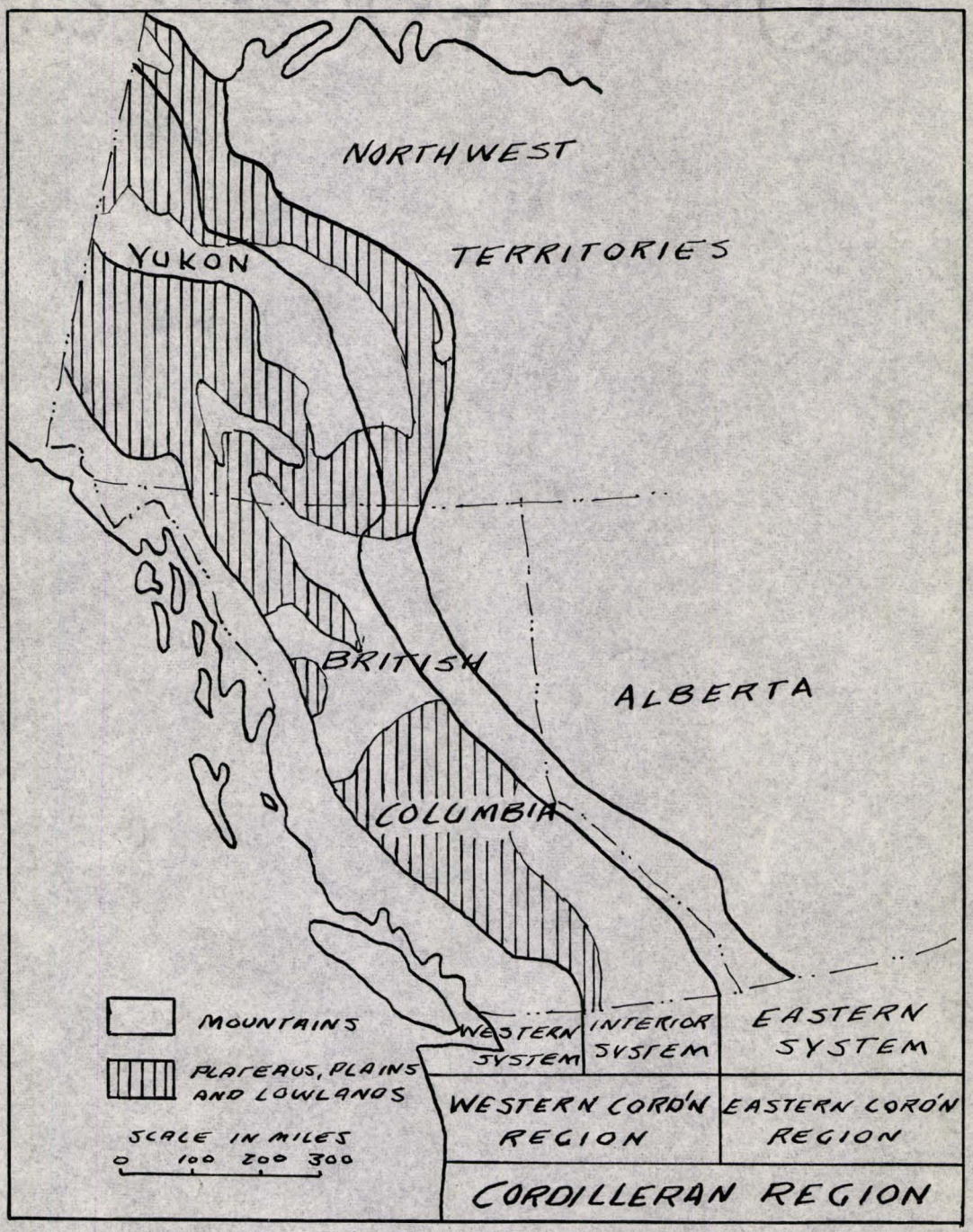


Plate 5 Physiographic divisions of the Cordilleran Region (after Stockwell, 1957).

The Arctic Archipelago

This major division includes all islands north of the Canadian mainland, together with Boothia and Melville Peninsulas, all of which are within the administrative district of Franklin in the Northwest Territories(Stockwell, 1957, p. 393).

Within this region of islands, the land surface includes mountains, uplands, plateaus, plains, and lowlands. Stockwell (1957, p. 397), points out that the physiography along with the bedrock topography of each island is related to the surrounding islands which indicates that the Arctic Archipelago was formerly a continuous landmass. The mountains of this region are developed on Precambrian rocks or folded Paleozoic limestones and trend northeast along the east boundary of the division. West of the mountains, the surface slopes down through plateaus, plains, and lowlands and rises again to a plateau level of 3600 feet along the western boundary(Stockwell, 1957, p. 397). The plateaus of this region are developed on unfolded Paleozoic limestone strata while the lowlands and plains are developed on flat-lying Paleozoic, Mesozoic, and Cenozoic strata(Stockwell, 1957, p. 397).

CONCLUSION

Much of the work done so far on the physiography of

Canada has dealt with the major divisions with subdivisions being recognized only in the more well developed areas such as the Cordilliran Region and the Appalachian Region. The lack of smaller physiographic divisions in northern Canada seems to be related to the lack of development and population in this remote region.

It appears from what has been said that there is room for further on the physiography of Canada. The fact that much of the area in northern Canada has had relatively small economic in the past is probably the main reason for the lack of information on this area. It seems likely that the establishment of early warning systems and trans-polar air routes will provide the impetus needed to encourage further work on the physiography of Canada.

REFERENCES CITED

Atwood, W. W., 1940, The physiographic provinces of North America: New York, Ginn and Co.

Dunbar, C. O., 1957, Historical geology: New York, John Wiley and Sons.

Eardley, A. J., 1951, Structural geology of North America: New York, Harper and Brothers.

Lobeck, A. K., 1948, Physiographic provinces of North America: New York, The Geographical Press.

_____, 1950, Physiographic diagram of North America: New York, The Geographical Press.

Putnam, D. F., 1952, Canadian Regions: New York, Thomas Y. Crowell Co.

Kurtz, V. E., McNair, A. H., and Wales, D. B., 1950, Stratigraphy of the Dundas Harbour area, Devon Island, Arctic Archipelago: Geol. Soc. Amer., Bull., v. 61, p. 1479. (abstract)

Stockwell, C. H., 1957, Geology and economic minerals of Canada: Ottawa, Can. Geol. Survey, Series 1, 4th ed.

Tayler, Griffith, 1950, Canada: New York, E. P. Dutton and Co.

Thayler, W. N., 1918, The northward extention of the physiographic divisions of the United States: Jour. Geol., v. 24, (no. 2), p. 161-185.

Wilson, A. W., 1903, The Laurentian peneplain: Jour. Geol., v. 11, p. 615-668.